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ASHLEY RIVER POLLUTION STUDY, CHARLESTON, SOUTH CAROLINA, JUNE-JULY, 1965

Public Health Service
Athens, Georgia

1 August 1965

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ASHLEY RIVER POLLUTION STUDY

CHARLESTON, S. C.

JUNE - JULY 1965

SUMMARY REPORT

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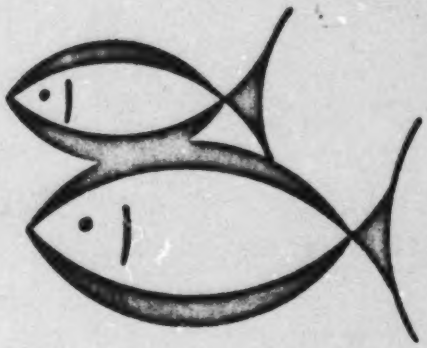

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U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

Public Health Service
Division of Water Supply and Pollution Control
Southeast Water Laboratory
Athens, Georgia

AUGUST 1, 1965

SUMMARY REPORT
Ashley River Pollution Study
Charleston, South Carolina

August 1965

The following brief report summarizes the findings of the investigations made by the Public Health Service, Division of Water Supply and Pollution Control, into fish kills in the Ashley River during the period of June 15-July 28, 1965.

CONCLUSIONS

1. Only one industry, American Agricultural Chemical Co., has effective waste control procedures in operation. All other industries and municipalities contribute untreated wastes to the Ashley River. Waste control practices at the Charleston Air Force Base are adequate for present conditions. Plant Hagood of the South Carolina Electric & Gas Company does not contribute to pollution as measured in this survey.

2. The Ashley River is grossly polluted by both domestic and industrial wastes.

3. There is evidence that the cause of fish deaths during the period June 21 - July 15, 1965, were the result of acetylcholinesterase inhibition such as could be caused by wastes discharged from the V-C Chemical Company.

BACKGROUND

Fish kills in the Ashley River at Charleston, South Carolina, have been reported on numerous occasions since 1961 by the South Carolina Wildlife Resources Department. In May 1965 the staff of the Public Health Service Charleston Harbor Project observed a kill of menhaden. An especially severe kill was brought to the attention of Washington Headquarters in mid-June. Investigations by the Technical Advisory and Investigations Section from the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, and the Southeast Water Laboratory, Athens, Georgia, were immediately initiated. Limited kills continued during the period of active field investigations (June 14-25, 1965) and again on July 15, 1965.

FIELD INVESTIGATIONS

Observations and field sampling were conducted by Public Health Service staff during the periods of June 15-18, June 21-25, July 6-8, and July 14-16, 1965. General water quality data have been collected routinely

from one station on the Ashley River since April 1964 by the Charleston Harbor Project and at the time of fish kills during November 1964 and May 1965.

The South Carolina Water Pollution Control Authority made, during recent months, field studies of the locations of municipal and industrial wastes outfalls discharging to the Ashley River. The Charleston Harbor Project studied discharges from five lift stations discharging untreated municipal sewage to the Ashley River during the period March 17 - April 10, 1964.

An inspection of waste treatment practices at the Charleston Air Force Base by the Public Health Service Division of Water Supply and Pollution Control Regional Office, Atlanta, Georgia was made on June 24, 1965.

RESULTS

Detailed memoranda and data developed during the various field studies and subsequent laboratory examinations are reproduced in the Appendix and summarized below.

Municipal Waste Discharges

Thirty-two municipal sewer outfalls to the Ashley River have been identified from South Battery up to Hunley Park. Three of these discharges are identified as having been treated in septic tanks, two from St. Andrews and one from a portion of The Citadel.

Samples from five lift stations discharging municipal wastes indicate a biochemical oxygen demand less than average for this type of waste. Cyclic variations over a 24-hour period appear normal. Both total coliform and fecal streptococci bacteria counts were high.

Charleston Air Force Base Waste Discharge

Domestic sewage from the Charleston Air Force Base and the Hunley Park area is treated in a primary treatment plant with post chlorination before discharge to the Ashley River. Metal plating wastes are discharged to the sanitary sewer system in small quantities at 4 to 6 month intervals. Wastes containing cyanides are removed for deep sea disposal. The major industrial water usage is in aircraft, engine, and automotive wash racks. The latter two use only alkaline detergents, while the aircraft washing operation uses detergents, kerosene, and about 55 gallons per month of methylene chloride. Wastes from the latter operation pass through a skimming tank before discharge. While floating oils were present in the discharge ditch within the confines of the base, they had largely disappeared at the point where the ditch leaves base property. Large quantities of oil were observed in bottom soils of this ditch.

Industrial Waste Discharges

Industrial water discharges to the Ashley River were identified from:

1. V-C Chemical Co.
2. Koppers Co., Inc.
3. Planters Fertilizer Co.
4. S. C. Electric & Gas Co.
5. Bird & Son, Inc.
6. American Agricultural Chemical Co. (Agrico)

Each of these plants was visited and a review conducted of waste handling procedures.

Plant Hagood of the South Carolina Electric & Gas Co. discharges only cooling water to the river. Any temperature rise occasioned by this appears to have negligible effect on the river.

The American Agricultural Chemical Co. produces fertilizer and sulfuric acid. All wastes are reclaimed for subsequent processing at another plant. The cooling water effluent from this plant was of the same character as the raw water source.

Bird & Son, Inc., manufactures roofing and siding. The principal waste source volume comes from washing operations (3000 gpm, 20 hrs. per day). These wastes contain soap and residual dyes. A wide variety of dyes are used in batch operations (approx. 300 gal. each) discharged from one to four times daily. Analysis of the two samples obtained from this plant indicate a high pH and normal metal concentrations. The wastes were not further characterized.

Koppers Co., Inc. produces treated wood products. Two waste discharges from this plant contain yard drainage and wastes from raw material recovery units. Both waste streams had high metal concentrations, principally iron, manganese and zinc. One discharge contained 450 ppm phenols. The matched sediment sample at this point contained 2 percent phenols.

The V-C Chemical Co. produces a wide variety of inorganic and organic phosphorus chemicals. Production of inorganic materials and of Merphos (S,S,S-tributyl phosphoro-trithioite), a defoliant, is continuous. Other organic phosphorus products are made in batches. In addition, sulfuric acid is produced at two V-C Plants with fertilizer also being made at one of these. There are three principal waste discharges to the river from this company. Each of these discharges plus other waste streams within the plant grounds was sampled. Where possible, matched sediment samples were taken.

There were substantial metal concentrations in several of the V-C wastes. Maximums of 6,900 parts per billion (ppb) of iron, 2,100 ppb zinc, 700 ppb lead and 200 ppb copper were found. One sample contained 300 ppb chromium, and another 700 ppb cadmium. The pH of the wastes varied considerably--from a low of 0.5 in one sample from a fertilizer plant to a high of 10.5 in the Merphos plant waste effluent.

A nematocide, VC-13 [0,0 diethyl 0 - (2,4-dichlorophenyl) phosporothioate] manufactured by V-C Chemical Co. was recovered in 10 waste water samples and 4 sediment samples from the plant area. One waste water sample contained 6,500 ppb of this material. The matched sediment sample contained 300,000 ppb. Merphos expressed in terms of a degradation product, was recovered in six waste water samples, and in three sediment samples. The maximum water concentration was 15,000 ppb. At this sampling point, the sediment contained 0.5 of 1% of the material.

V-C 13 and Merphos were confirmed by gas chromotography. An unidentified thiophosphorus material appearing on the chromatograms was confirmed as a degradation product of Merphos. The same peak was observed on Merphos standard chromatograms where the standard had been held in the laboratory for a period of time. Confirmation was obtained by subjecting both materials to infrared spectroscopy and nuclear magnetic resonance spectroscopy. Mass spectrographic analysis is now being done and should assist in positive identification of the substance. The degradation of Merphos is a natural process and was not induced.

Planters Fertilizer Co. manufactures sulfuric acid and fertilizer. Two waste ditches leave the plant area; one defined as being process, the other as roof drainage. Both waste sources had high metal concentrations. One sample contained 8,800 ppb of iron and 2,000 ppb of manganese. Another contained 1,400 ppb zinc, 6,500 ppb copper and 2,300 ppb manganese. Two samples from the process ditch had extremely low pH--1.7 and less than zero.

River Samples

The Charleston Harbor Project collected samples for routine sanitary analysis at the time of fish kills on November 18, 1964 and May 12, 1965. Dissolved oxygen values were normal on both occasions. Total phosphates were higher in the vicinity of and above the V-C Chemical Co. during the May 1965 sampling than at stations lower down the river. These samples were taken on an incoming tide.

Routine sanitary quality tests have been run on Ashley River samples collected in the vicinity of the Coast Guard Station at varying intervals of time since April 1964. Dissolved oxygen levels are between 60 and 100 percent of saturation, though untabulated data for late July 1965 indicate a 50 percent saturation on a few occasions. Bacterial analyses indicate

gross pollution of human origin. Of 94 total coliform determinations, only three were less than 1000/100 ml., while 72 per cent were greater than 5000/100 ml. Of 93 fecal coliform determinations only two were less than 100/100 ml., 69 percent were greater than 500/100 ml., and 46 percent were greater than 1000/100 ml. Total phosphates at 10 sampling points in Charleston Harbor during a March 1965 intensive survey indicate substantially higher values at Station 3, the only Ashley River station, than at other locations. Total phosphate data collected at varying time intervals since September 1964 are similar.

Five river water samples collected between June 23 and July 15, did not contain any organophosphorous materials. Two samples analyzed for phenols were negative. Metal concentrations were not unusual.

One special water sample (CSC-32) was collected by Charleston Harbor Project personnel in the vicinity of the V-C plant on July 12. They noted a film on the surface of the river, quite widespread, and having a lemon odor. This sample contained 1,900 ppb of VC-13 and 7,300 ppb of Merphos and its degradation product.

River sediment samples were collected on July 14-15. Two samples taken approximately 5 and 7 miles above the industrial complex were negative for organophosphorous materials. A sample taken approximately 40 ft. off shore from the V-C Chemical Co. Merphos outfall contained 500,000 ppb. of VC-13 and 1,600,000 ppb. of Merphos expressed as degradation product. The other two samples, downstream from the V-C Plant, did not contain VC-13, but did contain 3,000 ppb and 210,000 ppb of Merphos and its degradation product.

FISH STUDIES

Acetylcholinesterase (AChE) is an enzyme which catalyzes the hydrolosis of acetycholine to choline and acetic acid. This enzyme, found primarily in nervous tissue, is responsible for regulating the impulse-conducting ability of the nervous system. Organophosphorous pesticides owe their toxic properties to their ability to chemically combine with AChE. This results in an enzyme that is no longer capable of carrying out its normal function. Inhibition of this enzyme results in the inability of the nervous system to carry out normal control functions in an organism. Death will occur if the enzyme is sufficiently inhibited. It has been reported in the scientific literature that a number of fish tested began to show some evidence of poisoning by organophosphorous compounds when the brain AChE level was about 15 percent inhibited and that death began to occur at approximately 40 percent inhibition.

Dying menhaden, Brevoortia tyrannus (Latrob), were obtained from the Ashley River by Southeast Water Laboratory personnel. The level of brain

AChE activity in these fish was compared with that in control fish obtained from the Atlantic Ocean off Beaufort, North Carolina. The AChE activity was inhibited 49.3 percent. The Bears Bluff Laboratory of the South Carolina Wildlife Resources Department obtained samples of live menhaden and croakers, Micropogon undulatus (Lin), from the Ashley River and samples of croakers from the Ashapoo River. Brain AChE inhibition in live menhaden from the Ashley was 26.3 percent compared to the Atlantic Ocean fish and 35.5 percent in the croakers when compared with the Ashapoo samples.

In vitro inhibition of AChE activity was demonstrated for chloroform extracts of two waste samples from the V-C Chemical Co. and one from Planters Fertilizer Co. The Merphos degradation product also caused in vitro AChE inhibition.

DISCUSSION

Fish kills in the Ashley River have been reported at frequent intervals since 1961. The episode under study began in May 1965, and dying fish were observed on May 12, June 15, 16, 17, 18, 21, 22, and July 15, during the periods of active field study.

While the fish kills during the period June 21 - July 15, 1965, are the result of acetylcholinesterase inhibition, such as could be caused by the wastes from the V-C Chemical Company, the specific causes of fish deaths on any other occasion is conjectural. Any of the various wastes being discharged to the river can, in sufficient concentrations, alone or in combinations, cause such kills. Fish kills will undoubtedly continue to occur until all waste sources now entering the river are adequately controlled.

ACKNOWLEDGMENTS

Cooperation in the conduct of this study has been afforded by many individuals and public and private organizations. The industrial concerns visited were most cooperative. In particular, the cooperation of Dr. G. Robert Lunz of the South Carolina Wildlife Resources Department and Mr. W. T. Linton of the South Carolina Water Pollution Control Authority was most helpful.